IN THE SPECIFICATION:

1. Please add the following heading and paragraph on Page 1 after the Title of the Application as follows:

CROSS-REFERENCE TO RELATED APPLICATION(S)

The present application claims priority under 35 U.S.C. § 365 to International Patent Application No. PCT/IB2003/006248 filed December 29, 2003, entitled "METHOD AND DEVICE TO MAINTAIN SYNCHRONIZATION TRACKING IN TDD WIRELESS COMMUNICATION." International Patent Application No. PCT/IB2003/006248 claims priority under 35 U.S.C. § 365 and/or 35 U.S.C. § 119(a) to Chinese Patent Application No. 02160462.2 filed December 30, 2002 and which are incorporated herein by reference into the present disclosure as if fully set forth herein.

2. Please amend Page 1, Lines 5-6 as follows:

The invention relates to a method and device to maintain synchronization tracking, and, in particular, to a method and device in a [[TDD]] Time Division Duplex (TDD) Wireless Communication System.

3. Please amend Page 1, Lines 7-22 as follows:

TD-SCDMA is a 3G standard adopted by [[ITU]] the International Telecommunication Union (ITU). It takes ~~advantages~~ advantage of TDMA and synchronous CDMA[[,]] and provides high spectrum efficiency and service flexibility. In a TD-SCDMA system, it is very important

that [[UE]] user equipment (UE) is synchronized to the received signal from Node-B. In general, signal synchronization can be divided into two stages: final synchronization and synchronization tracking. The base of synchronization is on a chip level. Every chip in Node-B is shaped into an ISI-free waveform by using a shaping filter, as shown in Figure 1. Denote the waveform function of an RRC filter as f(t). In a UE system, to acquire the maximum SINRN, the UE should sample at the peak of the chip waveform, corresponding to ~~time=0~~ time = 0 in Figure 1. In TD-SCDMA, there are two sub-frames in each radio frame, which is of [[10ms]] ten milliseconds (10 ms) length. The sub-frame format is shown in Figure 2. In a sub-frame, there are seven common time slots and two special time slots. The two special time slots include DwPTS and UpPTS. In Figure 3, the structure of a common time slot is shown. There are two data parts in one time slot, and in the middle of the two data parts, there is a midamble part. ~~Midamble~~ The midamble is used to estimate the radio multi-path and is also quite important in maintaining the downlink synchronization.

3. Please amend Page 1, Line 24 to Page 2, Line 8 as follows:

After having acquired the initial synchronization of the downlink signal, the UE enters into the stage of keeping the synchronization. Because the UE does not know the exact time offset information between the local timer and the downlink signal from Node-B, traditionally an X-times sampling rate is used, [[here]] where X is an integer larger than 1, i.e. 2, 4 or even 8. Then the UE uses an RRC filter to filter the sample stream. The filter output will shape an auto-correlation waveform of SYNC-DL. The highest peak corresponds to the most likely

synchronization point. Using the method, the synchronization time error will be within $[-T_c/2X, T_c/2X]$. "Early/late gate" is a commonly [[seem]] seen implementation according to [[above]] the theory set forth above. Another commonly used synchronization method is "τ dithering loop".

4. Please amend Page 2, Lines 9-14 as follows:

Because a high value of the sample multiple X raises the speed requirement for [[A/D]] an analog to digital (A/D) converter, bigger buffer size and computation complexity are required. ~~And then those~~ Bigger buffer size and computation complexity will raise the cost of the hardware system and the consumption of the A/D conversion. So in general, a smaller sample multiple X is better, but if the sample multiple X is too small, then the synchronization precision will decrease. ~~so from above X is set as 4 often~~ Therefore, the sample multiple X is often set to a value of four (4).

5. Please amend Page 2, Lines 16-20 as follows:

The invention ~~want to resolve~~ resolves the technical problem of providing a new interlaced sampling method to sample the midamble part in a TD-SCDMA time slot, and in this way, when the sampling multiple is [[1]] one (1), the system still ~~keeps goodish~~ provides a good synchronization tracking performance. When the sampling multiple is [[1]] one (1), namely, the real offset within $[-T_C/2, T_C/2]$, rough synchronization has been acquired.

6. Please amend Page 2, Line 21 to Page 3, Line 3 as follows:

The ~~technical project~~ method of the invention includes the following steps:

a. Divide a midable into two parts, then detect the first [[one]] part of the midamble and the second [[one]] part of the midamble, respectively;

b. [[Do]] Perform an auto-correlation operation of the ~~above~~ two parts and the corresponding part of the local midamble to obtain an amplitude for each of the two peaks;

c. ~~compare~~ Compare the amplitudes of the two peaks;

d. Decide ~~advances or retards of~~ to advance or retard a local timer [[base]] based on the compared results.7

The [[said]] sample time point for detecting the midamble is:

7. Please amend Page 3, Lines 6-15 as follows:

Here, Ω must be a ~~smaller~~ small value, because if Ω is too ~~bigger~~ big, the auto-correlation peak ~~shown in Fig. 8~~ will decrease, which is a disadvantage to channel detecting. The principle ~~to select~~ for selecting the Ω value is that Ω is a random value less than [[¼]] one fourth (¼). In this way, the time difference between (n+ Ω) T_c and (n- Ω) T_c is less than half of the chip period [[,]]. The midable {m1, m2, m3,... m144) is divided into an odd part {m1, m3, m5, ... m143} and into an even part {m2, m4, m6,... m144}. ~~Detect~~ The method detects the odd part and the even part of the midamble by using a match filter and ~~obtain~~ obtains two peaks [[,]]. The method then ~~compare~~ compares the amplitude of the two peaks ~~amplitude~~. If the ~~latter~~ amplitude of the peak of the even part is higher than the ~~former~~ amplitude of the peak of the odd

part, ~~advance~~ the method advances the local timer by Ω T_c [[;]]. ~~by contraries~~ On the contrary, if the ~~former~~ amplitude of the peak of the odd part is higher than the ~~latter~~ amplitude of the peak of the even part, ~~advance~~ the method advances the local timer by - Ω T_c [[;]]. ~~the said~~ The midamble is also a downlink synchronization sequence.

8. Please amend Page 3, Lines 16-24 as follows:

~~Thereinafter, take~~ Take the 16th midamble as an example. When ~~use other~~ one uses another signal sequence, the result is the same. As the odd part and the even part [[has]] have the same auto-correlation peak and the peak is [[the]] half of the auto-correlation peak of the entire signal sequence, one can assume that the sampling offset is τ. ~~Under adopting~~ Using a normal sampling method, the peak of the midamble auto-correlation is ~~direct~~ directly proportional to $f(\tau)$[[,]]. ~~however~~ However, ~~adopting~~ using the interlaced-sampling method of the invention, the peak of the midamble auto-correlation is proportional to $[f(\tau+\Omega)+f(\tau-\Omega)]/2$, so that the normalized error of channel detecting that is induced by interlaced-sampling will be about:

$$2f(\tau)/[f(\tau+\Omega)+f(\tau-\Omega)], \quad -T_c/2<\tau<T_c/2 \quad (1)$$

9. Please amend Page 4, Lines 1-9 as follows:

As can be seen, [[the]] both peaks are nearly the same except that the peak amplitude of the latter [[one]] peak (the even part) is a little lower than the former [[one]] peak (the odd part). Compared with the ~~normal~~ prior art method, the new interlaced-sampling method will only harm [[SNR]] the signal to noise ratio (SNR) of the channel detecting very slightly by using the

midamble. By using [[this]] the new method of the invention, the sample frequency can be decreased to only one time of the chip rate and TD-SCDMA can still maintain the ability to track the downlink synchronization. In this way, ~~it can be allowed to~~ one can adopt a cheaper [[A/D]] analog to digital (A/D) converter and [[to]] greatly reduce the buffer size ~~greatly~~. The tracking error can be ~~mostly~~ substantially within the range [$-T_c/16$, $T_c/16$], which is same as the error that occurs when ~~adopting normal~~ one uses the prior art method [[and]] with X = 8.

10. Please amend Page 4, Lines 11-19 as follows:

~~Fig 1.~~ FIGURE 1 is an RRC Shaping Filter Response.

~~Fig 2.~~ FIGURE 2 is the structure of a sub-frame.

~~Fig 3.~~ FIGURE 3 is the structure of a time slot.

~~Fig 4.~~ FIGURE 4 is the error of channel estimation with an interlaced midamble.

~~Fig 5.~~ FIGURE 5 is the sampling point offset of current data parts.

~~Fig 6.~~ FIGURE 6 is ~~a concrete mode of~~ an advantageous embodiment for carrying out the invention implemented in [[the]] a device of downlink synchronization tracking in a TDD wireless communication system[[.]]; and

~~Fig 7.~~ FIGURE 7 is ~~concrete mode of~~ an advantageous embodiment for carrying out the invention implemented in [[the]] a triggering device in the device shown in ~~Fig 6~~ FIGURE 6.

11. Please amend Page 4, Lines 21-23 as follows:

In an initial ~~designing~~ design, the value of Ω is set as [[1/16]] one sixteenth (1/16). By controlling the triggering pulse to the A/D converter, the sampling time points for all the [[864]] eight hundred sixty four (864) chips in a time slot are

12. Please amend Page 5, Lines 4-12 as follows:

The [[said]] letter n [[is]] designates the chip location, the [[said]] Ω designates a random value less than [[¼]] one fourth (¼), and the [[said]] T_c designates the chip period. In the example, the [[said]] midamble is a midamble. The midamble {m1, m2, m3, … m144} is divided into an odd part {m1, m3, m5, … m143} and into an even part {m2, m4, m6, … m144}. Detect the odd part and the even part of midamble using a match filter and obtain two peaks, then compare the amplitude of the two peaks ~~amplitude~~. If the latter (even part) is higher than the former (odd part), advance the local timer by $T_c/16$[[;]]. ~~by contraries;~~ On the contrary, if the former (odd part) is higher than the latter (even part), advance the local timer by $-T_c/16$[[;]]. [[said]] The signals sequence can be the midamble, and also the downlink synchronization sequence.

13. Please amend Page 5, Lines 13-18 as follows:

According to ~~above~~ the method set forth above, because the peak of the auto-correlation of the odd part (and the even part) has only half the amplitude of that of the entire midamble, in a noisy environment, the [[SNR]] signal to noise ratio (SNR) of the odd part (and the even

part) is [[3 dB]] three decibels (3 dB) lower than that of the entire midamble. This may lead to more errors in comparison of the auto-correlation peak amplitude of the odd part and the even part. Next, [[a]] an example will be ~~taken~~ given to explain the feasibility of the method of the invention ~~method~~.

14. Please amend Page 5, Line 19 to Page 6, Line 2 as follows:

Assume that one vehicle runs at 120 km/hr and moves 0.167 m in every sub-frame time (5 ms). When the distance between the UE and the Node-B is changed because of movement, the UE should advance/retard the local downlink timer by $T_c/16$ (the chip rate is 1.28M, T_c = 781 ns). In the time period [[time]] $T_c/16$, a wireless wave can transmit 14.5 m distances at 300,000 km/s, which means: if the UE really [[need]] needs to advance/retard the local downlink timer because of movement, it can make a decision after comparing the auto-correlation peak of the odd part and the even part in as many as [14.65/0.167] = 87 sub-frames. There are at least two downlink time slots in one sub-frame, so in 87 sub-frames there are at least 174 usable ~~midamble~~ midambles to be decided. This makes a nearly error-free decision.

15. Please amend Page 6, Lines 3-9 as follows:

According to the calculation above ~~deduction~~, there can be as many as 174 comparison results. If more than [174 (1 + Δ) / 2] = N_T results are positive, the local timer advances $T_c/16$[[;]]. ~~on the contrary,~~ Otherwise, the local timer retards $T_c/16$. Here [•] means the integer no greater than. If there are not more than NT positive or negative comparison results, the local

timer remains unchanged. Here the symbol Δ [[is]] represents a protection margin which is used to avoid unnecessary dithering of the local timer (in the following mathematical analysis, Δ is set [[as]] to a value of 0.1).

16. Please amend Page 6, Lines 10-12 as follows:

When the vehicle speed is lower than 120 km/hr, the UE can compare auto-correlation peaks of more than 174 odd and even parts before making a decision. This will lead to better performance.

17. Please amend Page 6, Lines 13-17 as follows:

As can be seen in ~~Fig 5~~ FIGURE 5, Δ marks an odd sampling point [[,]] and ∇ marks an even sampling point. Assume that the sampling point of the current data part has an offset T_{offset}, $-T_c/2 < T_{offset} < T_c/2$ [[,]]. [[then]] Then correct tracking will advance the local timer by $\pm T_c/16$ towards the correct direction. ~~So correct~~ Correct tracking is [[the]] an important precondition [[of]] for implementing the invention.

18. Please amend Page 6, Lines 18-20 as follows:

In the analysis, maybe the selected parameters are not the best (such as the value of Δ, the interlaced offset Ω and the adjustment step $T_c/16$, etc.) but in a real environment they can be tuned to perform better.

19. Please amend Page 6, Line 21 to Page 7, Line 8 as follows:

As can be seen in ~~Fig 6~~ FIGURE 6, ~~there is~~ a device for downlink synchronization tracking in a TDD wireless system is shown, which includes the following connected in turn:

[[A/D]] An analog to digital (A/D) converter 1 to convert analog signals to data signals;

~~Distributor~~ A distributor 2 to divide a midamble into an odd part and an even part;

Two [[FIFO]] first in first out (FIFO) memories 3 to temporarily save the signals from ~~Distributor~~ the distributor 2;

[[Dot]] A dot product unit 4 to [[do]] perform an auto-correlation operation to the odd part and to the even part of the midamble from the FIFO memories 3 and the respectively corresponding part of the local midamble;

A Compare Decision unit 5 to compare the auto-correlation peaks of the [[both]] odd and even parts; and

A ~~Local~~ local timer 6 to decide advances or retards according to decision results.

The output signals of [[said]] the local timer 6 triggers [[A/D]] the analog to digital converter 1 through triggering mechanism 7.

20. Please amend Page 7, Lines 9-12 as follows:

As can be seen in ~~Fig 7~~ FIGURE 7, there is a triggering mechanism 7 for downlink synchronization tracking in TDD wireless communication. The triggering mechanism 7 includes: [[the]] a first counter 71 to provide pulse indicating, [[umpty]] a plurality of switches 73, 74 and 75, [[the]] and a second counter 72 to provide chip location indicating.

21. Please amend Page 7, Lines 13-20 as follows:

The [[said]] switches turn on and turn off according to the pulse indication of the first counter 71 and the location indication of the second counter 72. The [[said]] first counter 71 is hexadecimal. The [[said]] switches include the following three switches: [[he]] the first switch 73, the second switch 74 and the third switch 75. When the pulse identification is [[15]] fifteen (15), the chip location indication is 353 ~ 496 and is even, the first switch 71 closes; when the pulse indication is [[1]] one (1), the chip location is 353 ~ 496 and is odd, the second switch 74 closes; and when the pulse indication is [[0]] zero (0), the chip location is 1~352. 497~864 the third switch 75 closes.

22. Please amend Page 7, Lines 21-25 as follows:

The invention ~~does not be~~ is not restricted to ~~above~~ the method and device described above. The device shown in ~~Fig 6~~ FIGURE 6 and ~~Fig 7~~ in FIGURE 7 ~~are also~~ may also be implemented ~~adopting software~~ partly in software [[,]]. ~~such as the said~~ The midamble can be also divided into two parts using other [[way]] methods. So all the technical changes that are known by ~~the person~~ persons who are skilled in the field should fall into the protective scope of the invention.